A Perspective on Quadrennial Defense Review Influences on Situational Awareness from Space – One Man's Views

Keynote Presentation

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Let me begin by welcoming you, friends and allies, to this conference.

The NATO Alliance has been an enduring testament to the dedication of people in many nations to work together to protect and defend the freedoms we all cherish so dearly. Also allow me to express my appreciation for the honor you have bestowed on my by providing this opportunity to present the keynote address.

In my remarks I will discuss a number of challenges that have been identified in the 2006 Quadrennial Defense Review of the U.S. Department of Defense. I will also present my own personal views on how we may need to employ space systems in the future to meet those challenges. I must emphasize that these are one man's opinions intended to serve as food for thought in your subsequent discussions. In no way do these views represent an official position of the U.S. Department of Defense.

Let me begin by describing where I reside in the organizational structure. I serve as the Director of the Space and Sensor Technology Office and report to the Deputy Under Secretary of Defense for Science and Technology. My responsibilities include providing oversight for all of the space platform, space launch, sensor, electronics, and electronic warfare science and technology efforts sponsored by the Department of Defense. This includes Science and Technology efforts performed by our military services and the defense agencies such as DARPA, DTRA and MDA. In general terms, these efforts represent an annual investment of slightly less than 2 billion U.S. dollars every year.

What is the Quadrennial Defense Review – or as we call it, the QDR. As the name implies, it is a review we perform every four years. Its purpose is to look where we have come from. To look to where we need to go in the Future. And an opportunity to incorporate lessons learned since the last QDR. Some people think of it as a blueprint for change. The 2001 QDR identified the need to begin the process of transforming the Department of Defense to meet challenges anticipated in a 21st century world.

Published just 19 days after the attack on September 11th, it recognized that our defenses must be structured and able to operate effectively in a world of uncertainty and surprise. The subsequent terrorist attacks in Bali Turkey, Spain, and London have only emphasized that we all face new forms of threats – especially threats posed by non state actors able to inflict sudden death and destruction within our homelands.

Substad, J. (2006) A Perspective on Quadrennial Defense Review Influences on Situational Awareness from Space – One Man's Views. In *Space Sensing and Situational Awareness* (pp. 1-1 – 1-6). Meeting Proceedings RTO-MP-SET-105, Paper 1. Neuilly-sur-Seine, France: RTO. Available from: http://www.rto.nato.int/abstracts.asp.

Report Documentation Page						*Form Approved* *OMB No. 0704-0188*
Public reporting burden for the collection of information is estimated to average 1 hour per response, including the time for reviewing instructions, searching existing data sources, gathering and maintaining the data needed, and completing and reviewing the collection of information. Send comments regarding this burden estimate or any other aspect of this collection of information, including suggestions for reducing this burden, to Washington Headquarters Services, Directorate for Information Operations and Reports, 1215 Jefferson Davis Highway, Suite 1204, Arlington VA 22202-4302. Respondents should be aware that notwithstanding any other provision of law, no person shall be subject to a penalty for failing to comply with a collection of information if it does not display a currently valid OMB control number.						
1. REPORT DATE **01 APR 2006**		2. REPORT TYPE **N/A**				3. DATES COVERED **-**
4. TITLE AND SUBTITLE **A Perspective on Quadrennial Defense Review Influences on Situational Awareness from Space One Mans Views (U)**						5a. CONTRACT NUMBER
						5b. GRANT NUMBER
						5c. PROGRAM ELEMENT NUMBER
6. AUTHOR(S)						5d. PROJECT NUMBER
						5e. TASK NUMBER
						5f. WORK UNIT NUMBER
7. PERFORMING ORGANIZATION NAME(S) AND ADDRESS(ES) **DOD, Office of the Secretary of Defense, Dept of Defense 1777 North Kent Street, Suite 9030 Rosslyn, VA 22209 USA**						8. PERFORMING ORGANIZATION REPORT NUMBER
9. SPONSORING/MONITORING AGENCY NAME(S) AND ADDRESS(ES)						10. SPONSOR/MONITOR'S ACRONYM(S)
						11. SPONSOR/MONITOR'S REPORT NUMBER(S)
12. DISTRIBUTION/AVAILABILITY STATEMENT **Approved for public release, distribution unlimited**						
13. SUPPLEMENTARY NOTES **See also ADM401234. RTO-MP-SET-105, presented at the RTO Sensors and Electronics Technology Panel (SET) Specialist Meeting held at the Maui High Performance Computing Center (MHPCC), Maui, Hawaii, USA, 24-25 April 2006., The original document contains color images.**						
14. ABSTRACT **See the report.**						
15. SUBJECT TERMS						
16. SECURITY CLASSIFICATION OF:			17. LIMITATION OF ABSTRACT	18. NUMBER OF PAGES		19a. NAME OF RESPONSIBLE PERSON
a. REPORT **unclassified - NATO**	b. ABSTRACT **unclassified**	c. THIS PAGE **unclassified**	**SAR**	**6**		

Standard Form 298 (Rev. 8-98)
Prescribed by ANSI Std Z39-18

In the 2006 QDR the impact of this changing security environment was recognized as a need to have capabilities in four distinct areas. We must maintain our capacity to deter, and if required, decisively defeat nation state actors within the context of traditional conventional military operations. Maintaining this specific capability has been a fundamental tenet of our alliance.

Our extensive experience in this domain provides us a robust understanding of the parameters associated with developing space-based assets to provide the situational awareness required to successfully conduct such traditional force on force military operations. While we can expect bad actors to continue to develop denial, deception and camouflage technologies to degrade our sensing capabilities, I am confident our extensive experience in this measure versus countermeasure game will enable us to continue to surmount those challenges. Consequently, I will not discuss this area further.

Beyond the arena of conventional operations, we enter the realm of non-traditional operations. The terrorist attacks I mentioned earlier are just one manifestation of this challenging domain. For example, an adversary may seek to hide in the open – conceal his presence by blending in with the normal routine of the locale. This difficulty in locating and tracking in this situation may be compared to finding the proverbial needle in a haystack.

As we look to the future we find we must be able to deal with the challenge posed by weapons of mass destruction in the hands of terrorists or rogue states. The awesome destruction that can be caused by these makes them a major area of concern. Yet our ability to locate, tract and ultimately neutralize them or prevent their use is lower than what we would desire. For example, synthesis of chemical or biological weapons can be accomplished by perverting otherwise legitimate industrial equipment

Detecting such misuse, especially when this misuse is done surreptitiously and infrequent, is a significant challenge. Low tech radioactive weapons – those that simply seek to disperse nuclear materials to contaminate urban areas is a particularly difficult challenge. They do not require traditional nuclear facilities such as reprocessing or refinement plants to create weapons grade materials. Obtaining the requisite situational awareness to detect the assembly and transportation of such low grade nuclear materials by terrorists is one of those very difficult challenges we must overcome.

Finally, we have the newly emerging challenge area – the development of disruptive military technologies by a potential adversary. For more than half a century, the NATO allies have enjoyed an unmatched technology-based military superiority over any potential adversary. While we may expect this will persist as long as we continue to improve current systems and develop new military capabilities, we must remain cognizant that many other nations are now developing significant indigenous technology capabilities.

These efforts can lead to development of new advanced technologies adaptable to military use. Whether those disruptive technologies are employed directly by bad actor nations or are simply put on the market for exploitation by others, we must recognize we may face possible adversaries that have developed disruptive capabilities intended to severely degrade or even negate our existing advantages.

Before discussing these specific challenge areas in additional detail, I want to discuss the factors that govern how we can employ space assets. To first order there are two major aspects we must always consider. The first is the costs of access and the value, in terms of quality and timeliness, of the obtainable information. The cost of access has two specific elements – the financial cost of placing an asset in orbit and the cost, in terms of time, before we obtain useful information.

The financial cost is determined by the size of the asset and the energy required to place the asset in the desired orbit. Large complex satellites take longer to design and develop and thus have higher cost premiums.

Large, meaning expensive, launch vehicles are needed when high mass or physically large satellites are to be placed in orbit. Finally, placing such satellites at very high orbit altitudes or high orbital inclinations requires the use of even larger launch systems. As we all know, launch vehicle size goes hand-in-hand with cost – the bigger they are the more they cost.

The longer period of time required to develop and build a large complex satellite folds into the "timeliness" aspect. Long development cycles, historically some have been 10 or more years in duration, will increase the length of time between when a data acquisition need is identified and when the desired product is delivered. This may be acceptable when the data acquisition need can be forecast well in advance. However, in a world expected to provide sudden and unpredictable challenges, we will need to be able to either deploy or adapt situation awareness assets much more rapidly.

Similarly, the capability to redeploy an asset already on orbit to another location must be accomplished on a time scale matching future needs – not past paradigms consistent for a set piece battle planned well in advance.

Continuing on the second factor, the information obtainable by a space platform is determined by its field of view, the period of time it can observe a given portion of the earth's surface and the degree of granularity in its sensing capability. For any given sensor system, field of view is governed first by orbital location. Increasing orbit altitude increases field of view. This allows observation of ever larger sections of the earth's surface.

For example, an asset in the geosynchronous orbit can observe almost half of the earth's surface. However, the increased distance from the surface acts to significantly reduce the sensitivity or resolution of any particular sensor we might employ. Increasing orbit inclination increases the ability to observe more of the earth's surface during the course of any given revolution – even when using lower altitude orbits. Thus lower sensitivity sensors could be employed in comparison to what would be required for a "GEO" satellite.

However, a lower altitude high inclination orbit concurrently reduces the time any one spot will be under observation. Additionally, the time between sequential revisits may increase dramatically. Consequently, continuous observation is not possible unless many many such assets are employed.

This brings us to the classic trade space. We can fly at lower altitudes and collect information at high resolution for any given sensor sensitivity – but only at the expense of reduced fields of regard and longer revisit cycles between sequential observations. Conversely we can employ very high orbit altitudes to obtain a more comprehensive picture. However, we must employ a larger or more sensitive sensor if we do not want to compromise the clarity of our observations.

From the traditional perspective – supporting classical conventional military operations – this trade has almost always favored large satellites at high orbit altitudes. So what happens when we use the new perspectives from the QDR?

First, what are some of the shifts in emphasis that were identified in the QDR?

The QDR highlighted some of the key end states that need to be achieved to meet the challenges posed by the irregular, catastrophic and disruptive mission area. They show a recurrent theme: the need to have the ability

to rapidly learn, adapt and adjust our methods. The capability to deal with ever evolving threats that will target perceived vulnerabilities by non-traditional means to focus on outputs and effects – are we succeeding? And to obtain the critical information in a timely manner to make these other capabilities possible.

Hopefully, this list makes it apparent that continuing to rely primarily only upon a new generation of large satellites that take a decade or more to develop and deploy, even if they have higher performance sensors, is not going to be the optimal approach. This does not mean that they will not continue to have an important place in our space architecture. We will still need such systems to maintain our traditional warfare capabilities.

However, to play a fully effective role in this new strategic environment will require re-thinking how we design and employ such systems. For example, more emphasis may be required on maximizing capability through software adaptation rather than driving the hardware components to the highest level of potential performance. Increasing ability to enable time critical responsive adaptive planning may require modifying operational approaches rather than relying on preplanned and pre-programmed past plans.

We may find it better to tie them into semi-autonomous networks where other systems, whether based in space or other domains, can dynamically re-task them to address suddenly emerging needs or opportunities.

How we employ these sensors may also need to be revisited. Even today, we can collect more raw data than we are able to rapidly evaluate. Simply increasing the volume of raw data will not enhance our ability to provide timely actionable intelligence. Some believe that the solution to this lies in developing more powerful ground processing systems employing advanced algorithms.

An alternative could be more intelligent sensors on our satellites. Rather than just providing the next "picture" satellites with systems that also report on what has changed since the last set of observations – namely perform on-board change detection capability can provide both analysts and warfighters with more time critical knowledge – information on what and where something is happening now. This would require greater on-board storage and processing capabilities.

Some might claim that is not achievable in the near term. Yet when I look at the multiple gigabytes of information I can store on this simple memory stick, I have to wonder if we are exploiting such emerging technologies rapidly enough?

Other types of space situation awareness systems with greater flexibility will also be required. We will need an ability to develop and deploy new types of sensor payloads. These will be needed on much faster timelines to keep pace with the ever more rapid development of militarily useful commercial technologies

Some believe small satellites, whether mini or micro in size, may help to fill this need. Today we are able to develop and deploy such miniaturized assets on more rapid schedules – typically 2 to 3 years in comparison to the decade or more required for a major asset. However, even more rapid cycles will probably be needed.

Their development cost also is a fraction of that of a major asset allowing one to contemplate deploying a constellation of such assets to enhance revisit times. Their low mass also enables use of small and lower cost launch vehicles – again, another factor in their favor. However, we would need to develop much more capable sensor payloads to avoid the maxim "little satellites can only perform little mission". This may require development of mini satellite systems that can form sparse aperture arrays. Mini-satellites that deploy micro-satellites in their wake as part of a sensor net to increase persistence is another idea possibly worth exploring.

Finally, using mini- or micro-satellites as part of a space system architecture to facilitate low data rate communication connectivity to any location on the earth may enable getting the right bits of urgent data to the most disadvantaged user – the special operator unable to depend upon more conventional communication paths.

In summary, I hope I have been successful in laying out both challenges and a few thoughts on how we may overcome them

The new challenges we all face are apparent – the solution of space to overcome those challenges is limited only by our imagination!

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